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Colorado Department
of Public Health
and Environment

February 23, 2011

To Public Water Systems

Subject: Acceptance of nanofiltration and reverse osmosis (NF/RO) filtration technologies as Alternative Filtration Technologies for meeting the *Colorado Primary Drinking Water Regulations* (CPDWR) requirements for *Giardia lamblia* and *Cryptosporidium* Removal

To Whom It May Concern;

The Water Quality Control Division (the Division) has reviewed industry best practices, relevant literature from other state regulatory agencies, and the related research report published by the United States Bureau of Reclamation in accordance with Article 1.11.2 and Article 7 of the *Colorado Primary Drinking Water Regulations* (CPDWR). **The Division hereby finds that nanofiltration and reverse osmosis filtration can be successfully used to comply with the filtration requirements of Article 7 of the CPDWR**. The technology meets or exceeds the requirements of the *State of Colorado Design Criteria for Potable Water Systems* and is accepted for use as an Alternative Filtration Technology subject to the performance conditions outlined in Table 1 and the Additional Design Criteria given in Table 2.

This acceptance addresses the following types of filtration systems:

- Nanofiltration
- Reverse osmosis filtration

This acceptance applies only to the use of nanofiltration and reverse osmosis filtration for compliance with Article 7 of the CPDWR (the surface water treatment rules). It does NOT constitute construction approval for installation at individual public water systems.

Public water systems must submit for individual review and approval to use this technology. Each approval will be handled on a case-by-case basis by the Division as required by Article 1.11.2 of the CPDWR.

As part of this review, the Division has evaluated the following documents:

- April, 2000 Desalting and Water Purification Research Report No. 55, "Methods for Monitoring the Integrity of Reverse Osmosis and Nanofiltration Membrane Systems" – United States Department of Interior Bureau of Reclamation Technical Service Center.
- Dow Water Solutions – FILMTEC ™ Reverse Osmosis Membranes Technical Manual

Table 1. Nanofiltration and Reverse Osmosis Conditions of Acceptance:

Filter Log Removal Compliance Credit*	
Giardia lamblia	3.0 - Log
Cryptosporidium	3.0 - Log
Virus	no credit granted
*** Compliance credit does not necessarily reflect demonstrated performance.** These filters may be used as final compliance filters as part of a multiple treatment barrier approach to meeting SWTR requirements. The water system must provide, in addition to filtration, a **minimum of 4.0-Log virus inactivation by disinfection**. The filter log removal credit for compliance with LT2ESWTR will be determined by the Division on a case by case basis.	
Technical Specifications – to be submitted for EACH approval	
Filter Model	**Manufacturer must provide individual model numbers.**
Validation of support layer pore size	Each manufacturer shall provide a statement verifying that the support layer for the NF/RO membrane consists of pores that are **less than one micron absolute**. One micron nominal support layers will not be allowed.
Maximum Flux Rate	To be specified by the manufacturer at a specified temperature.
Maximum Transmembrane Pressure	To be specified by the manufacturer.
Turbidity Performance Standards	< 0.1 NTU 95% of the time Not to exceed 1 NTU
Verification of construction material	
Membranes	Each manufacturer shall provide evidence that the membrane has been certified to the ANSI/NSF Standard 61 or equivalent.
Housings and appurtenances	Each manufacturer shall provide evidence that all ancillary equipment to the membranes have been certified to the ANSI/NSF Standard 61 or equivalent.

Table 2. Nanofiltration/ Reverse Osmosis Filtration Additional Design Criteria:

Additional Design Criteria
1. Pretreatment may be required depending upon raw water quality. An evaluation of raw water quality and pretreatment requirements must be performed by the design engineer and the filter vendor. The evaluation must be included in the engineering plans and specifications which are submitted to the Division for review and approval.
2. Continuous online pressure monitoring and recording must be provided to monitor transmembrane pressure on each membrane bank.
3. A means to isolate and control the flow across each module shall be provided.
4. A means to measure and control flow across each membrane bank or skid will be provided.
5. A means to chemically clean the membranes shall be provided. Post cleaning, effluent shall be tested to confirm the absence of cleaning chemicals prior to return to service.
6. Adequate backflow prevention must be provided for chemical cleaning. Chemical waste must be neutralized as necessary and properly disposed. Drains that contain waste from the membrane unit must

have an air gap or hazardous cross connection control device prior to joining a main waste line.

7. Block and Bleed Valves must be provided on the membrane permeate line to ensure that no cleaning chemicals enter the drinking water supply.
8. As required by Part 1.2.11 of the State of Colorado Design Criteria for Potable Water Systems, any materials that come in contact with the water will be certified under ANSI-NSF Standard 61. This includes all piping, raw water tanks, filtered water tanks, backwash tanks, and contact time tanks associated with the unit. Product certification documents must be provided to the Division for review and approval as part of the engineering plans and specifications submittal.
9. As required by Part 1.2.11 of the State of Colorado Design Criteria for Potable Water Systems, any chemical additives that come in contact with the water will be certified under ANSI-NSF Standard 60. This includes all treatment chemicals. The Division does not consider cleaning chemicals to be in contact with potable water provided sufficient flushing occurs after each chemical cleaning.
10. Bypass piping to divert water around the filter unit (including blend water) without additional treatment will not be allowed for NF/RO filtration for compliance with Article 7 of the CPDWR. Any bypass streams will also be required to meet all filtration/disinfection requirements of the CPDWR.
11. An evaluation of potential impacts to corrosivity of finished water due to NF/RO treatment and compliance with the Lead and Copper Rule must be provided in the engineering plans and specifications submittal. This can include:
    a. Pilot data showing corrosivity of the finished water
    b. Calculations of Langelier Saturation Index and calcium carbonate precipitation potential for the finished water

Additional Operations and Maintenance Criteria

1. Recognizing that direct integrity tests cannot be performed on a regular basis for NF/RO systems, the Division expects a surrogate membrane integrity testing protocol to be developed for each installation. At a minimum, systems must monitor the following in both the raw and finished water:
    c. Daily total dissolved solids (TDS) in order to determine if a membrane has been breached, and
    d. Based upon the raw water analysis performed for the design, the System must propose an additional constituent to be monitored weekly. This constituent must be present in sufficient quantity, be rejected by the membrane at >95%, AND must be monitored weekly in lieu of a direct integrity test. Examples include sulfate or total organic carbon (TOC).
2. The water system shall provide a written membrane diagnostic plan to address any events where the indirect integrity testing above fails.
3. The Public Water System will keep a record of all direct and indirect integrity tests and make the document available for review by the Division.
4. The PWS must provide a plan to ensure that all cleaning chemicals are flushed from the unit before returning to service.
5. An Operations and Maintenance Manual will be provided for all installations.

Please be aware that any point source discharges of water from treatment facilities are potentially subject to a discharge permit under Colorado's State Discharge Permit System. Any point source discharges to state waters without a permit are subject to civil or criminal enforcement action.

Please direct any further correspondence regarding this acceptance to:

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Water Quality Control Division
4300 Cherry Creek Drive South
Denver, CO 80246

If you have any questions or comments, please call Tyson Ingels at 303-692-3002.

Sincerely,

Tyson Ingels, P.E.
Lead Drinking Water Engineer
Engineering Section
Water Quality Control Division

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